Television Reduced To

The General Electric Company, at Schenectady, is experimentally broadcasting television.

Here is all the data that is needed to enable the radio fan to pick up these signals and make a picture out of them.

The purpose of the following description is to point out the essentials in the method and show how simple the receiving apparatus may be.

Reduced to its easiest terms, television reception consists of some white and black dots arranged in proper order on a flat screen at persistence-of-vision speed. This is strikingly illustrated when one cuts off the motor and discovers that the picture instantly vanishes and in place of it is a great collection of unrelated dots.

With a neon lamp and almost any motor to rotate a suitable disc, these radio signals can be made into a picture. With the only lamps available at present, the pictures will not be very large. The lamp first referred to is the General Electric Co.'s G-10 lamp, 1/4 watt, cylindrical off 48 dots, spaced very accurately in even decre-

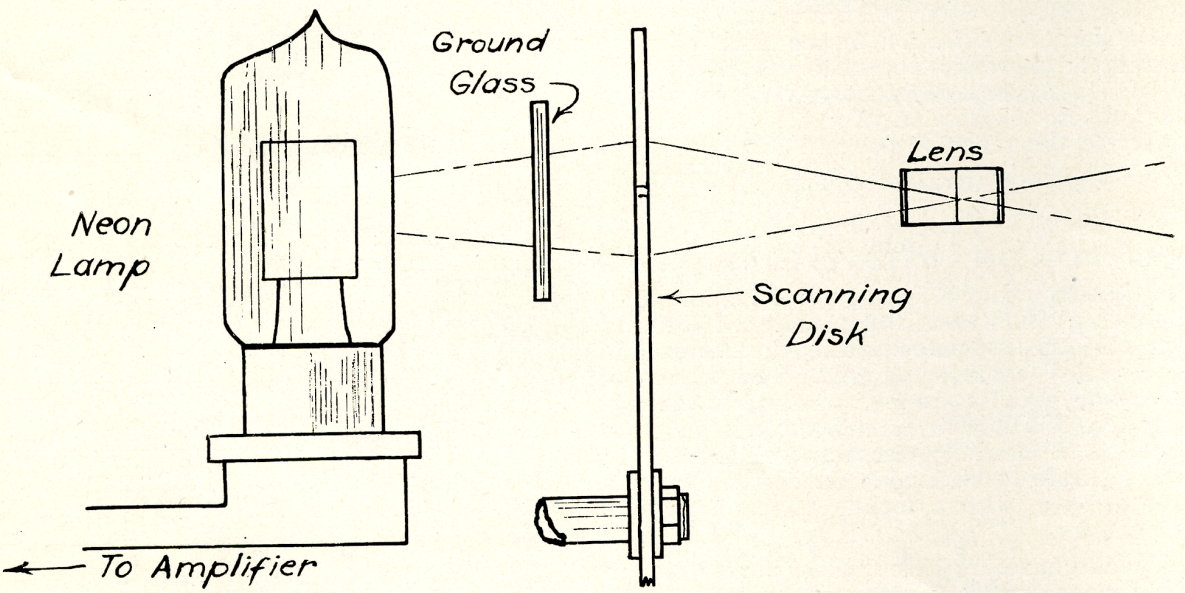
audio stage of the receiver. The incoming signals blink this light in a picture order.

You can listen to these picture signals but they don't make sense. However, if you will start the motor and look at the neon lamp through the flying holes in the disc you will see a lot of black and white dots and dashes scattered over the picture area and probably without intelligible order at first.

If however, the speed of the disc is slowly increased until it is in synchronism with the transmitting station, a perfectly formed picture suddenly flashes out on the picture plane.

The picture will tend to move to the right or left but by increasing or decreasing the speed of the motor the picture can be held rather steady in the lighted plane.

If you are in the direct current district, a direct current motor with an adjustable rheostat in the field of the motor, gives the necessary speed adjustment to bring the disc into synchronism with the transmitting station. Another



The motor should be at least 1/16 h. p., and preferably attached to the house-lighting circuit. A flanged hub is mounted on the motor shaft to carry the scanning disc.

The disc is 12 inches in diameter and has 48 tiny holes therein, arranged about 5/8 inch apart and in a spiral of a mean diameter of 9½ inches. The holes should be approximately 1/32 inch in diameter; and the inner end of the spiral is ⅝ inch shorter radius than the outside end.

The neon lamp is attached, like a loudspeaker, to a radio receiving set, with perhaps 250 volts of battery in the circuit. You may find it desirable to increase the bias on the grid. The above voltage is only necessary when using the smaller adjustable resistance in series as a vernier helps to more easily hold the motor in synchronism.

If you have only alternating current available then the cone pulley arrangement must be used. For that matter, the cone pulley scheme can be worked with any kind of motor.

The making of the disc is difficult, but it can be bought very cheap. Here is what is needed if the disc is to be made—cardboard, or black piece of paper. Cut a 12-inch disc out of it, with an accurately located centre opening to go on the flanged hub on the motor. On this disc lay ck 48 dots, spaced very accurately in even decrements of radius to give about a ⅝-inch offset of

Its Simplest Terms

By L. SIGMON

the ends of the resultant spiral arrangement of dots on the disc.

Take a sewing needle. Break off the eye and the point. This is to be used as a punch to cut tiny holes in the disc where you put the dots. Lay the disc on a block of wood sawed so short that the punching can be done in the end grain on the wood. Or get a piece of lead, and scrape it smooth and cut the holes in the disc by punching out the tiny discs of paper, with the needle-punch, which will leave the holes in the paper cut clean.

Thin metal sheet or bakelite, or almost any other material can be substituted for the paper or thin cardboard disc, but the paper disc is easier to make.

A suitable hub, with nut and two washers between which latter the disc is clamped is also needed.

A ground-glass plate about one inch square is mounted near the rotating disc. It may be on either side, that is, next to the lamp, or on the opposite side of the disc from the lamp, in alignment with the holes in the disc. In the first mentioned position one looks at the illuminated disc through the tiny holes; in the other position the glass is illuminated by the light from the lamp shining through flying holes, to build up the picture.

The ground-glass can be made, if it is not readily available, by rubbing a piece of clear glass on a very fine sandpaper to which a little oil or turpentine has been applied.

Mat celluloid film or mat surface mica will also answer very well. The impression of good workmanship is heightened if one mounts it in a small frame, like a picture frame.

The radio picture signals broadcast by WGY are sent out from pictures made up of 48 lines to the picture. The rate is about 16 to 18 complete pictures per second.

The received picture can be made to seem about a 1½ inch square by looking at it through a reading glass, or a condenser lens such as is used in magic lanterns and motion picture theatre projectors.

The best type of amplifier to use with "Television" is, the resistance-coupled amplifier, either the three or four-stage type.

If resistance-coupled amplifier is employed, it will be necessary to raise the detector B-voltage in the receiver to an approximate value of 45 to 67½ volts.

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History and Organization of the School of Eng'r. Radio Club

The "School of Engineering" had for some time felt the need of a well organized radio club for the students, therefore, on October 4, 1926 was born what is now known to be "The School of Engineering Radio Club". This club owes its conception to the following men:

Mr. F. Vebber.

Mr. W. P. Gainer—8AEE, 9CXY, Commercial operator.

Mr. N. J. Richard—ex8BZT, Commercial operator.

Mr. R. J. Tayek—9DKD, 9ERI.

Mr. H. Holmberg—8DQQ.

Mr. B. J. Chromy.

These men were students of S. O. E. and vitally interested in amateur radio activities, being amateur radio operators themselves. Their aim was to promote amateur radio among the students of the school. Considerable credit is due to Mr. F. A. Vaughn, Vice-president of the school, for his sincere cooperation, by advising and helping in the formation of this new organization.

The objectives for and upon which this club was founded are, namely:

To encourage experiments in amateur high frequency transmission and reception by arousing a lively interest therein.

To spread the knowledge of the means and processes by which such transmission and reception is made possible.

To afford a center where all who are interested in the "science of radio" may meet and exchange their knowledge and experience.

Again we repeat that October 4, 1926 marks the date of birth of "The School of Engineering Radio Club". Mr. B. J. Chromy (now assistant radio patent examiner at Washington, D. C.) was the first president. He proved his ability to organize and manage the club by paving the way and laying the foundation for the present organization. Mr. Chromy's term of office was short, however, because of his graduation from the school and having to assume his duties at Washington.

Mr. W. P. Gainer was the second president and during his term of office the club became affiliated with the "American Radio Relay League" and the club's amateur radio station W9SO was remodeled and extended until today it stands in the foremost ranks of amateur radio stations in the United States.

The third and present president of the club is Mr. N. J. Richard and among the achievements of the past year were namely:

The gaining of a much larger membership. The arranging of a series of lectures on the "Theory and Operation" of transmitters and receivers, to be delivered at the regular weekly meetings by such men as Mr. T. J. Bailey, Radio Interference Investiator of the T. M. E. R. & L. Co. of Milwaukee; Mr. M. Jameson of the Allen Bradley Co. of Milwaukee, the radio instructors of the school, Mr. M. Ert, president of the W. R. T. A., and many other men of note in the radio engineering profession. These lectures, in many instances, were followed by practical demonstrations of fundamental principles of radio. Code classes were arranged in which the members had the opportunity of becoming familiar with the International Morse Code. A Question-Box was also established by which the Technical Committee arranged to answer all questions and problems of the members, as concerning Short-wave Transmission and Reception.

The Club owes its success to the cooperation and interest shown by all the members and we take pride in saying "that from its embryonic stage to its present status, The S. O. E. Radio Club has shown remarkable success and is rapidly achieving prominence in the field of national amateur radio activities.

Following is a brief description of some of the outside activities of The S. O. E. Radio Club and amateur station W9SO.

The School of Engineering amateur station was the first in the world to receive the reports of the recent Porto Rico hurricane.

W. P. Gainer and C. H. Scholten, students of the school and members of the Radio Club, were the operators who picked up the signals of NAU, a United States naval station at San Juan. The antenna of NAU had been torn away by the terrific gale, but government operators were able to rig up a 40-meter set with which they radioed the news. Gainer picked up the distress signals at 1:15 a. m. Communication between the station and the outside world had been cut off for almost 24 hours. After several attempts Gainer managed to cut in and advised the sending station that he would take the message. The Naval station replied that it had an urgent message for Washington. Gainer took the first message of 142 words in Continental code. This message was then sent to Washington. A few minutes later a second message was received and dispatched to Washington by telegraph.

The following day the Porto Rican station NAU confirmed in a dispatch to Washington, the report that W9SO had been the first to pick up messages from the temporary set. Gainer said that the Porto Rican signals came in strong and that he had no difficulty in taking the message. The West Indian station reported that W9SO's signals were steady and clear.

Mr. Gainer and Mr. Scholten were honored by the United tSates Navy. Admiral T. T. Craven, Great Lakes, Ill., expressed the navy's appreciation in the following dispatch to the school:

"The chief of naval operations desires to express his appreciation of the excellent work done by two of your amateur operators in copying and

forwarding a radiogram from Porto Rico," the dispatch says. "Not only does this show very good operating ability, but the forwarding of the dispatch to the navy department indicates excellent initiative."

Another outstanding event in the activities of the club was the assistance rendered to the Wisconsin News in conducting the Radio Silent Mystery Dance held in Juneau Hall of the Milwaukee Public Auditorium during the last Radio Show.

The Transmitting and Receiving equipment which made that novel feature possible was under the technical supervision of F. A. Vaughn, vice-president of the school. This was the first appearance of "silent dancing" in this country.

Mr. Vaughn was assisted by six members of the Radio Club, all of whom were licensed amateur or commercial operators. Of this group, W. P. Gainer and L. C. Sigmon were in charge of the transmission. R. J. Tayek and H. L. Holmberg handled details relating to the power supply and N. J. Richard and C. H. Scholten were in charge of the receiving apparatus used by the dancers.

* * *

SPECIAL TRANSMITTER USED

The transmitter used was one of a series of transmitters forming the equipment of the School of Engineering amateur station W9SO. It was formerly under the call letters of 9EMT and owned by Mr. L. C. Sigmon. It was necessary, however, to completely redesign and rebuild the transmitter to meet the special requirements of silent dancing. The transmitter went on the air at the Radio Show under the call letters of KGIE, these letters being designated in a license issued by the Federal Radio Commission. Station KGIE was rated at 7½ watts and

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The Development of Amateur Short Wave Radio Apparatus

Before the war practically no regulations had been made to govern the transmitting amateur radio fan. Consequently it is very difficult to discuss amateur experimentation as a whole because there was no union among the persons who were experimenting and each ran those experiments which he considered valuable to himself, in this way some being interested in certain branches of reception, others in transmission developments.

Before 1912 very little was done in cross country communication, in fact, and to be able to transmit only a few miles was esteemed to be a great achievement. Up to this time all amateur experimentation had been done with some fashion of spark coil transmitters and were used on almost any wavelentgh above 200 meters. Even up to 1924 most of the work was carried on on wavelenths of 200 meters. With the development of the vacuum tube, both transmission and reception were revolutionized. Now that most of the proper equipment could be purchased quite reasonably, amateurs were equipping their stations better and running more tests. One of the chief obstacles was the opening up of the new bands of less than 200 meters. Previous to 1924 it was generally accepted that wavelengths of less than 200 meters could be little used for transmission over great distances due to the high absorption factor. However, there was a small group of amateurs that had started experimentation on wavelenths less than 200 meters. In one of these groups was Boyd Phelps of Hartford, Conn. Some time prior to 1920 he had operated a spark transmitter on a wavelenth of 33 meters. A wavemeter calibrated down to 10 meters comprised a part of his equipment. Not having anyone to communicate with, this band was not investiagted before 1920. The first successful communication that was carried on was between Harry Lyons of Hyattsville, Md., and Robert Kruse of Washington, D. C., operating on 190 meters.

The following year Kruse communicated with Lyons on 160 meters with a vacuum tube transmitter. During August 1921 successful communication was carried on on 112 meters between Brookline, Mass., and Hartford, Conn. During the same year Phelps made a two way communication with Conrad 8XK in Pittsburgh on 90 meters.

In spite of all that the little bands of experimenters had done constant requests were received at the license bureau at Washington, D. C. for permits to use wavelengths exceeding 200 meters as the shorter wave tests were considered as just plain freaks. It was not till John Reinertz

(Concluded on Page 10.)

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Alternating Current Radio Tube Operation

In general, an alternating current-operated radio set is any set which may be connected directly to the light socket and operated without the use of batteries. There are, however, two distinct types of A. C. sets. The first type is the type which uses a rectified and filtered A. C. on the filaments, which is acquired by the use of either an "A" battery eliminator or D. C. supplied by the "B" eliminator circuit. In the second case it is essential that the current be low, because the transformer, rectifier and filter circuits of the "B" eliminator are not designed to carry a heavy current. This necessitates the use of tubes of the -99 type with filaments connected in series.

The second type of A. C. set is the one that uses the so-called "A. C. tubes", whose filaments operate directly on low voltage A. C. Of these A. C. tubes there are two types, the heavy filament and the cathode. In construction the heavy type filament tube is essentially the same as the battery type except that it has a heavy oxide-coated ribbon filament which requires a little over an ampere of current to operate. The reason for the use of this heavy filament will be given a little later.

In an amplifier circuit of a battery operated set the grid return is usually connected to the negative of the "A" battery, or to the negative of the "C" battery whose positive terminal is connected somewhere in the "A" circuit. If these connections were made in an A. C. set a terrific hum would be heard in the speaker which would badly distort even the strong local signals. Just how this hum originates and how to eliminate it requires a little reasoning. Consider a battery amplifier circuit whose grid-return is connected directly to the negative filament terminal. If a voltmeter were connected between the grid and different points of an incandescent portion of the filament it would be found that the voltage between the grid and filament would vary uniformly from Zero to IR volts. Where I equals the current in amperes flowing in filament and R equals the resistance of the filament this means that the grid voltage varies from Zero to IR volts. The mean of this, which is the actual grid voltage, equals -IR/2. In an A. C. set, where the filament is excited by A. C., the IR/2 grid volts become alternatey negative and positive which modulates the plate current and produces the hum. It will be obvious that the IR/2 grid volts could be eliminated to render the grid zero volts the hum would cease. The voltage is produced by the I flowing through R/2 ohms resistance or one-half the incandescent portion of the filament. Therefore, if the grid-return was connected to the midpoint of the incandescent portion of the filament the grid voltage would become zero. It is quite a difficult matter to make a permanent connection on the heated portion of the filament and it would also require an extra connection to the tube, which would be objectionable. This is overcome by either bringing out a center tap on the transformer, or connecting a 10 or 15 ohm resistance across the transformer terminals and taking a center tap off it. Either of these two methods are equivalent to making a connection at the mid-point of the filament. Let Ir1 and Ir2 equal the voltage drop of the left and right halves of the filament, and E1 and E2 the voltage of the left and right halves of the transformer winding. If a galvanometer were connected between the center of the heated portion of the filament and the center tap of the transformer winding and indicated zero the voltage at the two points would of course be equal. Consider Ir1, Ir2, Ir3 and Ir4 as the elements of a wheatstone bridge. To have a galvanometer read zero this following equation would have to be true: Ir2 x E1 equals Ir1 x E2. It is true because Ir1 equals Ir2 and E1 equals E2. This same method of analysis applies to the center tapped resistance across the transformer.

The question naturally arises, "Why not use the ordinary quarter ampere tube for this purpose?" The main reason why it is not used is because of the type of filament it uses. If we were to use a -99 or -O1A type for A. C. operation we would have an A. C. hum in the set which could not be balanced by our scheme of grid-return connection. Another peculiarity about this hum would be noticed. It would have a frequency twice that of the frequency impressed upon the filament. Most of the commercial A. C. lines have a frequency of 60 cycles, which means that the current rises to maximum and falls to zero 120 times per second. Although it cannot be seen, this rise and fall of current will cause an equally rapid rise and fall in the heat intensity of the filament. As the plate current will vary with some proportion to the heat intensity of the filament a 120 cycle hum will be heard in the speaker. The extent or amplitude of these undulations of heat intensity will depend upon the heat retaining qualities, or the thermal inertia or the filament. It is an established fact that as the temperature of an object rises the heat radiation is greatly increased. It is for these reasons that the heavy rugged ribbon filament operating at a low temperature is incorporated in the -26 type of tube.

The cathode type tube operates on an entirely different principle. This type of tube does not depend directly upon the filament for its electronic emission. The cathode, which is usually a round oxide-coated metallic cylinder of a diameter just large enough through which to pass the filament. The filament is heated by means of an A. C. current, which in turn heats the cathode, due to its proximity. The grid-return is connected directly to the cathode. No method of balancing out hum is required as the cathode is

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HISTORY AND ORGANIZATION OF THE SCHOOL OF ENG'R. RADIO CLUB

(Concluded from Page 7)

operated on a wavelength of approximately 200 meters at a frequency of 1500 kilocycles. The transmitter was located near Juneau hall where the dancing took place. The space devoted to the dancing represented an area of approximately 1250 square feet and was roofed with leafy decorations which effectively concealed the sending antenna. A system of counterpoise wires was laid beneath the floor so that the dancers would move in a field resulting from the radiations of the antenna and counterpoise.

* * *

DANCERS USE EARPHONES

Each dancer wore a pair of head phones in the band of which was installed a carborundum crystal detector for the purpose of picking up the broadcasting station's program. No battery or receiving antenna was used. These phones were prepared by members of the Radio Club.

THE DEVELOPMENT OF AMATEUR SHORT WAVE APPARATUS

(Concluded from Page 7)

had improved his regenerative short wave receiver so that it would work on wavelengths of as low as 130 and as high as 370 meters were the conditions much changed.

In June 1922 Secretary Hoover called a radio conference and restricted the amateurs to wavelengths of 150 to 200 meters, with few exceptions. These wavelengths were indorsed by the American Radio Relay League as traffic handling bands and in a short time were filled with transmitting amateurs.

Experiments were being conducted by many amateurs in the near proximity of 100 meters by the middle of 1923 and some two way contacts made distances of as great as 1000 miles, the trouble seeming to be in the receiver at this stage so the era of the low loss tuner was brought about by Kruse and Phelps as the result. By the latter part of 1923 exceptional results had been accomplished. It was in November of that year that 1MO in West Hartford, Conn., exchanged messages with French 8AB owned and operated by Leon Delroy in Nice, France. This was the first time that the Atlantic had been bridged.

During the rest of the year remarkable results were obtained and in the early part of 1924 the department of commerce issued new amateur regulations authorizing the use of the following bands, 150-200, 75-85.7, 37.5-42.8, 18.7-21.4 and 4.69-5.25 meters.

In September 1924 W. B. Wagner, 6BCP of San Pedro, Calif., succeeded in exchanging signals with Frank Bell, 4AA at Waihemo, New Zealand, and on the following night 4AA was in communication with 6CGW of Long Beach, Calif. All of this work had been done on wavelengths exceeding 200 meters.

The experimenters tirelessly trying to open up new fields in radio had been making tests on wavelengths using 40 meters and in the late spring of 1925 cross continental communication in the day time, this was considered remarkable, as before this time daytime communication had been very nearly out of the question.

The increased use of short waves brought about the necessity for having a tube with low value of interelectrode capacity. This difficulty was overcome when Dr. Lee Deforest invented his popular amateur tube known as the "H" tube. As a result, experiments were carried on on extremely short wavelengths, such as one to five meters, and in July, 1927, Kruse demonstrated a ¾-meter transmitter. Although these very short waves are of no real practical value as yet, it is hoped that they will be developed to that stage in the near future, as the recent radio regulations which restricted the amateurs to bands not exceeding 300 kilocycles are not sufficient in width to accommodate all of the transmitting amateurs without a tremendous amount of interference.

ALTERNATING CURRENT RADIO TUBE OPERATION

(Concluded from Page 8)

thoroughly insulated from the filament carrying the A. C. This type tube is used almost without exception in the detector circuit. If a -26 type tube were used in this circuit a bad 60 cycle hum would be generated because the grid-return is not connected directly to the center tap of the balancing resistor but is connected to the grid condensor. The grid condensor offers a very high impedance to a 60 cycle current, hence an A. C. voltage is built up on the grid due to electro-static capacity between the grid and the filament. This A-C. voltage on the grid produces a variation in the plate current which produces the hum. This is not the case with the -27 or cathode type tube as the cathode is at zero voltage in respect to the grid.

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COMMERCIAL ENGINEERS CLUB PLANS EXTENSIVE PROGRAM FOR YEAR

"The Commercial Electrical Engineers Club is looking forward to the best year it has ever had." This is predicted by Howard Funk, president of the C. E. E., who also states that, judging by the membership of the club and the enthusiasm of the members, the program of the organization for this year should meet with the approval of all C. E. E. men. The features, both social and instructive, to be offered in the future have been carefully worked out, and include moving pictures with accompanying explanations and sidelights pertinent to the subject being shown. Practical experiments in the more complicated lines of electrical apparatus will be conducted, social activities encouraged by actual participation of the club in them, and a number of other activities engaged in during the year.